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A METHOD OF CORRECTING BARK BEETLE SURVEY DATA
OBTAINED PRIOR TO COMPLETION OF ATTACK PERIOD

by

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Forest Insect Laboratory
Coeur d'Alene, Idaho
April 3, 1939

SUBJECT-

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Forest Insect Laboratory
Coeur d'Alene, Idaho
April 4, 1939

Dr. F. C. Craighead

Washington, D. C.

Dear Dr. Craighead:

I am enclosing a copy of a laboratory report outlining a method of correcting bark beetle survey data that are obtained prior to the completion of the mountain pine beetle attack period. As this is quite a departure from other methods of correcting these data now employed, I would appreciate your comments concerning the potentials of the method, with suggestions for improvements.

I experienced considerable difficulty in preparing a clear description of this method and hope that my readers will not have too great a task in understanding the procedure to be followed. I realize that as we put this method into practice there will undoubtedly be objections that will need be overcome. However, we feel that the importance of these subsequent attacks warrants our taking some steps towards establishing a method to provide for the proper interpretation of our survey data.

Respectfully yours,

JAMES C. EVENDEN
Senior Entomologist

Enclosure

cc to:
Mr. Miller
Mr. Keen ✓
Dr. Beal

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A METHOD OF CORRECTING BARK BEETLE SURVEY DATA
OBTAINED PRIOR TO COMPLETION OF ATTACK PERIOD

FORWORD

The first step in preventing the development of destructive epidemics of the mountain pine beetle (Dendroctonus monticolae Hopk.) is recognized as an adequate annual program of detection surveys. It is only from such surveys that potentially dangerous situations can be recognized while in their early stages, and artificial control instituted at a time when the greatest benefits will be derived at the lowest cost of operation. Obviously the value of these surveys rests in the accuracy of the data obtained. Not only must infested areas be properly sampled, but data must be taken that will depict the actual status of the current year's infestation, as well as permit a forecast of its subsequent trend.

In meeting the requirement of accuracy one of the most difficult problems has been to evaluate the attacks that occur after the survey of a specific area has been completed. This condition results from the prolonged attack period of the mountain pine beetle, which extends from June until September or sometimes later, depending upon weather conditions. Surveys conducted at any time during this attack period will only be as accurate as the percentage of the total attacks that have occurred by that date. The importance of these subsequent attacks is variable and will depend upon the time of the survey and the occurrence of unseasonal temperatures.

Although the relation of this prolonged attack period to survey data has been recognized for years, its maximum potentials were not fully appreciated. This lack of full appreciation was strengthened by the many outstanding examples of the accuracy of our surveys, which lead to the belief that the subsequent attacks were offset by compensating factors and that they did not materially increase the original estimate of infested trees. Such compensation could come from (1) counting light attacks that were finally "pitched out", (2) the natural tendency on the part of survey men during the early years of our surveys to include attacked trees that were just outside of strip line boundaries, (3) normal tendency to slightly overpace in rough country, which gives an inflated estimate of the number of infested trees, (4) a seasonal variation in the percent of the bole that is attacked, as when the upper portion of the bole is available the late attacks will often occur as "fill in" of previously recorded trees and not as additional attacked trees, (5) and of course the late attacks of the previous season, that are recorded as infested trees during the first part of the survey but from which the beetles emerge during September. All of these factors tend to cause an overestimation in the number of infested trees which in many instances was compensated by the late attacks, causing the final figures to be quite accurate. Although improvements in our surveys have practically eliminated those errors resulting from operating technique, those associated with seasonal variations will continue to play a part in the final summation of bark beetle survey data.

Regardless of the complexities of the problem, it is now appreciated that the importance of these attacks, as well as existing compensating factors, is sufficient to warrant their proper evaluation in the interpretation of survey data.

THE PROBLEM

Were it not for the element of time, an easy solution would be to postpone the institution of survey programs until the attack period is over. However, the portion of the field season remaining would be so short that in most cases the projects could not be completed.

Obviously the later such surveys can be instituted the less important the late attacks will become. In the past it has been necessary to institute the survey program adopted by the Coeur d'Alene Laboratory rather early in August in order to complete the work prior to the end of the field season. Furthermore, as in this region fall control is in most instances more advantageous than spring projects, it is necessary that surveys be conducted sufficiently early to permit arrangements for the institution of such projects by the 15th of September.

Permanent sample strip or plots examined at ten-day intervals, if representative of conditions, will establish the percent of the current season's attacks that have occurred by the date of examination and permit a fairly accurate correction to be applied to previously obtained data. Although this method has certain mathematical objections, the primary disadvantage rests in the size of the sample that would be required to provide significant data. In dealing with severe

infestations of the mountain pine beetle distributed over large areas of lodgepole pine, with a number of attacked trees per acre representative data could be obtained from a few sample strips. However, in dealing with outbreaks of this insect in western white pine, where the infestation varies from .10 to as much as 1.00 tree or more per acre, it is apparent that a much larger sample would be required. Under such conditions, where the subsequent new attacks will in most cases be less than the total number of infested trees indicated by the actual survey, the check sample would need be equal in area to the original survey if representative data are to be obtained. The use of this method of correcting survey data is limited by the labor required for obtaining adequate check data, as well as the inconvenience of returning to the area in question for periodic examination.

The possibility of developing a chart or graph portraying the trend of the seasonal attack period as advanced by Keen and Johnson* for the western pine beetle has been studied. The seasonal variation encountered with mountain pine beetle infestation in white pine would make the use of such graphic methods somewhat difficult. However, as more data become available it is possible that some modification of these methods may be applicable to this region.

* Unpublished office reports - "Estimating pine beetle losses during period of attack" by F. P. Keen, February 6, 1931, and "Correction factors for use in estimating total seasonal bark beetle losses in California" by P. C. Johnson, February 5, 1935.

With present information it would seem that the most feasible solution for this problem will be from data taken at the time of the survey. Although the obtaining of such data with nontechnical men is not an easy task, a tentative plan has been devised, which is intended to eliminate the present objection to August and early September surveys. During the 1938 season a similar plan was tested. Although based upon the same entomological foundation as the method proposed in this paper, it was not satisfactory. These objections are believed to have been eliminated in the following tentative solution.

A POTENTIAL SOLUTION

CORRECTING EACH DAY'S DATA BY THE PERCENTAGE OF THE INFESTED TREES RECORDED DURING THE SUBSEQUENT SEVEN DAYS THAT WERE ATTACKED DURING THAT PERIOD, AS WELL AS FOR EACH SUCCESSIVE WEEK THEREAFTER THROUGHOUT THE DURATION OF THE ATTACK PERIOD

This method satisfies the requirements of simplicity as far as the survey men are concerned, as it is based upon the occurrence of newly attacked trees with egg galleries of not more than 2 inches in length. This information is taken by the survey men, and is based upon an adequate basal examination, usually on all four sides of each infested tree. The maximum length of the galleries are used in making this determination and not the average. Galleries of not more than two inches in length, when found in the early part of the season,

represent attacks that are not more than one week old. During the latter part of the season a two-inch gallery may represent attacks of two or more weeks duration, depending entirely upon the occurrence of activity temperatures.

By using the percentage of the total season's attacks that have occurred during any one week, the data taken the day previous to this seven day period can be rightfully corrected by this amount. For example, on August 1 data obtained indicate an infestation of .8 tree per acre. During the following week, August 2 to 8 inclusive, 17 percent of the attacks recorded by the survey occurred during that period; therefore the data taken on the 1st can be corrected by 17 percent, which would increase the estimated infestation to .91 tree per acre. It is necessary to base this method upon the premise that the seasonal history of the mountain pine beetle will be the same throughout the area being surveyed. Although as far as the application of this method of correcting for subsequent attacks is concerned, this will in most cases be true, however it is recognized that there will be situations where data taken from one area will not be applicable to another.

The formula for this proposed correction can be shown somewhat graphically as follows:

To correct survey
data taken on

Aug. 1 - Infestation shown	(Percent of new attacks occurring) + (during period (Aug. 2-8 inc.)	(Percent of new attacks occurring) + (during period (Aug. 9-15 inc.)	To end of activity = X period
Aug. 2 - Infestation shown	(Percent of new attacks occurring) + (during period (Aug. 3-9 inc.)	(Percent of new attacks occurring) + (during period (Aug. 10-16 inc.)	To end of activity = X period
Aug. 10 - Infestation shown	(Percent of new attacks occurring) + (during period (Aug. 11-17 inc.)	(Percent of new attacks occurring) + (during period (Aug. 18-24 inc.)	To end of activity = X period

It will be seen that in arriving at a correction factor for each successive day's data one day is dropped from the first of each 7-day period and one added to the end. This can be further explained through the use of the form (table 1) provided for recording the data obtained by the survey crew, from which each day's correction factor is readily computed.

On this form the total number of attacked trees, as well as the number of so-called "new attacks" (egg galleries 2 inches or less in length) recorded by the entire survey crew for each day worked, is placed in the space or spaces opposite the date on which the data are obtained. There is only a single space for the first day's data, two spaces for the second day's, and for each day thereafter, each day's data will be entered in seven spaces. When no data are obtained the spaces are marked with a zero, but when no work is conducted (Sundays, holidays, moves, etc.) the spaces are filled with a line.

These forms will accomodate only 14 days' data. For additional sheets, the data are merely carried forward by setting the first date on the new sheet back 6 days.

At the bottom of each block, which depicts the data obtained during a seven-day period, there is a space for showing the totals of the two columns of figures. From these totals the percentage of new attacks for each block or seven-day period is computed. This percentage, which shows the attacks that have occurred during the week, becomes the correction factor for data taken 8 days previous. As new attacks will occur during the second and third weeks of the survey, and perhaps the fourth and fifth or more, it is also necessary to use the correction factor obtained during these successive seven-day periods. Each block is legended at the top by the letters A B C --- G in series of seven. These legends permit a quick and correct selection of the series of correction factors to be applied to any one day's survey data. To illustrate: Data taken on the first day of the survey would be corrected by the percentage of new attacks shown at the bottom of block "B". Block "A" could not be used, as it will be seen that the first day's data are included in the compilation. By using these legends the formula shown on page 7 is simplified as follows:

To correct survey
data taken on

Aug. 1 - Infestation shown + 1st B + 2nd B + 3rd B etc. =

2 - " " + 1st C + 2nd C + 3rd C etc. =

10 - " " + 2nd D + 3rd D + 4th D etc. =

By using the figures shown for illustration in table 1, if we assume that on the 3rd of August the survey data indicated an infestation of .80 tree per acre, we would have:

.80 tree per acre + 1st D + 2nd D + 3rd D =

or

.80 tree per acre + 13% + 13% + 4% = 1.06 trees per acre

In applying this formula the 4th D correction factor was not used, as from the data shown it was apparent that the new attack period was practically over and that the few trees with galleries of 2 inches or less were more than of one week's duration.

Although it is believed that this procedure offers a method for correcting survey data taken during the attack period, there are physical and perhaps statistical objections to it. The greatest difficulty will be to determine the period over which these weekly factors are to be applied. However, this requirement will be met by the Bureau officer in charge of the operation, based upon his own observation relative to seasonal history development, strengthened through data obtained by strip runners. Each strip runner records for all infested white pine encountered on his strip the brood stage

at the base of the tree. These stages usually run in the following groupings: (Eggs), (Eggs-Small Larvae), (Eggs-Small Larvae-Large Larvae), (Small Larvae-Large Larvae), (Large Larvae-Pupae-New Adults), (Pupae-New Adults). From this information, which is also required for the proper interpretation of the survey data, it is believed that this officer will be able to establish the period to which these corrections are to be applied with acceptable accuracy. Obviously the use of these correction factors will only be necessary through the most active attack period, which for normal seasons will not last much longer than the 10th to 15th of September.

CONCLUSIONS

This method of correcting survey data obtained prior to the completion of the attack period will be tested during the 1939 season as a possible solution. It is realized that changes will no doubt be necessary, and it is possible that the plan can be discarded entirely in favor of a simpler and more efficient procedure. However it is considered as a necessary step in attempting to make our bark beetle surveys more accurate and of greater service.

TABLE I.

RECORD OF BARK-BEETLE-ATTACKED TREES WITH EGG GALLERIES OF TWO INCHES OR LESS IN LENGTH

RECORD OF BARK-BEETLE-ATTACKED TREES WITH EGG GALLERIES OF TWO INCHES OR LESS IN LENGTH																												
Date of Survey	A		B		C		D		E		F		G		A		B		C		D		E		F		G	
Aug.	Attacks Tot.	New	Attacks Tot.	New	Attacks Tot.	New	Attacks Tot.	New	Attacks Tot.	New	Attacks Tot.	New	Attacks Tot.	New	Attacks Tot.	New	Attacks Tot.	New	Attacks Tot.	New	Attacks Tot.	New	Attacks Tot.	New	Attacks Tot.	New	Attacks Tot.	New
1	59	13																										
2	63	13	63	13																								
3	48	9	48	9	48	9																						
4	74	15	74	15	74	15	74	15																				
5	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
6	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
7	61	10	61	10	61	10	61	10	61	10	61	10	61	10	61	10	61	10	61	10	61	10	61	10	61	10	61	10
8	305	60	80	10	80	10	80	10	80	10	80	10	80	10	80	10	80	10	80	10	80	10	80	10	80	10	80	10
9	20%		326	57	72	8	72	8	72	8	72	8	72	8	72	8	72	8	72	8	72	8	72	8	72	8	72	8
10	X X X		17%		335	62	81	7	81	7	81	7	81	7	81	7	81	7	81	7	81	7	81	7	81	7	81	7
11			Aug. 1		18%		368	50	65	9	65	9	65	9	65	9	65	9	65	9	65	9	65	9	65	9	65	9
12					Aug. 2		13%		359	44	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
13					Aug. 3		12%		359	44	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
14							Aug. 4		12%		359	44	58	10	58	10	58	10	58	10	58	10	58	10	58	10	58	10
15							August 5		12%		356	44	38	6	38	6	38	6	38	6	38	6	38	6	38	6	38	6
16									Aug. 6		12%		314	40	75	9	75	9	75	9	75	9	75	9	75	9	75	9
17									Aug. 7		13%		317	41	62	5	62	5	62	5	62	5	62	5	62	5	62	5
18											Aug. 8		13%		298	39	58	4	58	4	58	4	58	4	58	4	58	4
19													Aug. 9		13%		291	34	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
20															Aug. 10		12%		291	34	-----	-----	-----	-----	-----	-----	-----	-----
																	Aug. 11		12%		291	34	-----	-----	-----	-----	-----	-----
																		Aug. 12		12%		-----	-----	-----	-----	-----	-----	
																			Aug. 13		-----	-----	-----	-----	-----	-----	-----	

CORRECTION FACTORS AND DATE OF SURVEY
DATA TO WHICH THEY ARE APPLICABLE

RECORD OF BARK-BEETLE-ATTACKED TREES WITH EGG GALLERIES OF TWO INCHES OR LESS IN LENGTH

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